Remarks

The claimed invention

The invention is a point detector system having a high quantum efficiency detection cell area that achieves a superior detection-signal-to-noise ratio by optimizing the size of the photon detection areas (pixels) in the detection cell area. The detection cell area is sized roughly equal to the area of the light beam generated by the light source in order to maximize the number of photons of the beam incident to the detector, thus maximizing signal strength. The detection cell area is comprised of the minimum number of pixels consistent with maintaining high quantum efficiency detection within each pixel. Thus, the detection cell area may be comprised of a single pixel of area roughly equal to the area of the light beam. Minimization of the number of pixels minimizes dark current noise signals. In the preferred embodiment, a charged-coupled device(s) (CCD) is used as the high quantum efficiency detection cell. The invention further includes a readout capacitor and apparatus for multiple transfers of a signal charge between the detector and the readout capacitor.

The cited art

Sampas discloses a CCD array imager used in confocal scanning microscopy. The Sampas' array is comprised of a horizontal unmasked (imaging) array of CCD pixels (wells in the Sampas' disclosure) affixed to tandem rows of a masked (storage) array of CCD pixels. An illuminating light beam is focused on the sample to excite the fluorescent molecules therein. A light beam of the resulting fluorescent photon emissions from a portion of the sample is momentarily focused through a collection lens assembly onto a single unmasked CCD pixel in the imaging array. After momentary illumination of the first individual pixel, the Sampas imager uses a scanning means to move the illuminating light beam to a second portion of the sample and to focus a resulting second fluorescent photon emission light beam from that second portion of the sample onto a second, single unmasked CCD pixel in the imaging array. Through repetition of these steps the image of the fluorescence emission pattern is scanned onto the CCD array. In

the Sampas invention, for a given CCD unmasked array area, use of a greater number of pixels of smaller area results in potentially higher spatial resolution.

Kovac discloses a circuit for processing signals produced through photo-excitation of an image sensing array. The Kovac signal processing circuit has two circuit structures, the dark current read-out register and the video (plus dark current) read-out register (Kovac Fig. 2 Nos. 20 and 30), in electronic communication with the output of each individual light sensing region of the sensor array. Kovac teaches a single measurement of video plus dark current signal of an illuminated light sensing region and a single measurement of the dark current signal of the same region when not illuminated.

Rejections under 35 U.S.C. 102

Claims 1-3, and 6 stand rejected under 35 U.S.C. 102 as being anticipated by Sampas. With direction to Claim 1, the sole independent claim, the Examiner states that "Sampas discloses a high quantum efficiency point detector system a light source generating a light beam having an area and a detector with a cell size comparable to light beam area " Applicant respectfully disagrees. Applicant submits that Sampas discloses only "optimization of the beam image size [area] relative to the pixel size[area]" (Sampas col. 5, lines 43-44). Sampas further discloses "[t]he optimum beam image size [area] for a given pixel size [area] is empirically determined as the size [area] which maximizes the capture of light from the illuminated region by the CCD electron well" (Sampas col. 5, lines 53-56). Applicant submits that the Sampas CCD electron well is a single pixel which is only a portion of, and not the whole of, the detection area of the Sampas CCD array. By contrast, the detector cell (or array) of claim 1 is optimized by matching the total cell detection area to the area of the light beam. Indeed, Sampas teaches away from illuminating the entire detection area. As a result, Applicant submits that independent claim 1 is not anticipated by Sampas. Claims 2-8 depend from claim 1 and are patentable in view of Sampas.

With direction to Claim 2 the Examiner states that "Sampas discloses wherein the cell includes a single pixel," citing Sampas col. 5, lines 1 –3. Applicant submits that Sampas does not disclose a detection cell wherein the cell includes a single pixel. Rather, Sampas discloses a "pixel in the first column in the imaging row of the array" (Sampas col. 5, lines 4-5). Further,

Sampas teaches mapping of an image "to the on-diagonal pixels of the [masked] CCD array, whereas the off-diagonal pixels [of the masked array] contain the noise" (Sampas col. 5, lines 26-28) For the masked CCD array to have both on-diagonal pixels and off-diagonal pixels, the unmasked CCD array must have more than one pixel. As a result, Applicant submits that claim 2 is patentable in view of Sampas.

With direction to Claim 3 the Examiner states that "Sampas discloses wherein the cell includes at least two pixels," citing Sampas col. 6, lines 23-37. Applicant submits that Sampas does not disclose a detection cell. Rather, Sampas discloses an auxiliary pair of pixels positioned to determine the alignment of the light beam with the axis of the CCD pixel array. (Sampas col. 6, lines 38-39). Further, Sampas teaches mapping of an illuminated sample image into "pixels in the unmasked (imaging) row of the array" (Sampas col. 4, lines 54-55). Sampas teaches a means of optical scanning that sequentially illuminates the sample in discrete steps along one, two or three dimensions. Sampas further teaches illumination of a single pixel in the CCD array at each discrete step. However, Sampas does not teach simultaneous illumination of all pixels in the detection area, as does the present invention (application page 1 line 32-34), nor does Sampas teach that illumination is limited to physically adjacent pixels as does the present invention (application page 2 line 25). Indeed, sequential illuminations of pixels in the Sampas linear array while scanning the sample in two or three dimensions necessitates that excitation radiation from at least some adjacent portions of the sample are mapped to non-adjacent pixels of the CCD array. Thus, the applicant submits that the Sampas array and the detector cell of the present invention are neither physical or functional equivalents. As a result, Applicant submits that claim 3 is patentable in view of Sampas.

Rejections under 35 U.S.C. 103

Claims 4, 5, 7 and 8 stand rejected under 35 U.S.C. 103 as being unpatentable over Sampas in view of Kovac. Applicant respectfully disagrees. Claim 4 has been amended to recite a readout capacitor and means for transferring, multiple times, charge from the detector to the capacitor and back. Applicant submits that Kovac does not disclose a means for transferring the charge back to the detector. With direction to Claims 4 and 5 the Examiner states that "Kovac discloses a detector system with [which?] includes a plurality [of] readout capacitor[s] and

means for transferring, multiple times, charge from the detector to the capacitor," citing Kovac Figure 2. Applicant submits that Kovac teaches only a single transfer of a given pixel charge to a readout capacitor for a single readout. In contrast, the present invention teaches multiple transfers of a given pixel charge back and forth between the detector (or transfer capacitor) and a given readout capacitor for multiple readouts. (application page 3 lines 5 – 13) Applicant submits that Claims 4 and 5 are not obvious over Sampas in view of Kovac and are patentable.

With direction to Claims 7 and 8 the Examiner states that Sampas in view of Kovac fails to disclose a plurality of transfer and readout capacitors are arranged in a pipeline configuration or in a cyclic pattern. However, the Examiner asserts that claimed arrangements of transfer and readout capacitors would have been an obvious design modification for one of ordinary skill in the art. Applicant respectively notes that the Examiner cites no prior art as a basis for such assertion.

Applicant further submits that claims 4, 5, 7 and 8 depend either indirectly or directly from claim 1 and are thus patentable thereover.

In light of the foregoing Amendment and Remarks, Applicant respectfully submits that the present case is in condition for allowance. A Notice to that effect is respectfully requested.

A Petition for Extension of Time under 37 CFR 1.136 and the appropriate fee are submitted herewith. Please charge any additional fees associated with this filing, or apply any credits, to our Deposit Account No. 03-1721.

Respectfully submitted,

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I hereby certify that this correspondance is being deposited with the United States Postal Service as first class mail in an envelope addressed to: Assistant Commissioner For Patents, Washington, D.C. 20231
on 12/20/01
Susan M. Donahue

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Additions are underlined and deletions are enclosed in brackets.

In the claims

4. The detector system of claim 1 further including a readout capacitor and means for transferring, multiple times, charge from the detector to the capacitor and back.